TOWARD SUSTAINABLE WATER PLANNING AND MANAGEMENT IN BRITISH COLUMBIA

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PREFACE

"Toward Sustainable Water Planning And Management In British Columbia" was prepared by Dr. J.C. Day and J.A. Affum as part of a project funded jointly by the British Columbia Forest Resources Commission and the British Columbia Round Table on the Environment and the Economy. It is part of a series of background reports dealing with issues which the Round Table considered important to the development of a sustainable development strategy for British Columbia. It is intended to provide information that will assist the dialogue between the Round Table and the public.

The Round Table has not endorsed the report. The information provided and conclusions reached in this document are those of the authors.

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EXECUTIVE SUMMARY

Toward Sustainable Water Planning and Management In British Columbia

This report focuses on the nature of British Columbia's water resources, the planning, allocation, and management systems that are in place, and an assessment of desirable changes.

The author indicates that the province's Water Act needs to be revised, especially to protect instream uses such as water to support fish populations and for diluting wastes.

The report recommends institutional changes so that the planning and implementation of provincial water policies would be separated from water resource development interests. It recommends that planning and allocation processes should be more open, including river basin development agreements negotiated amongst stakeholders.

It also calls for the development of appropriate indicators of sustainable water and land use.

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SUSTAINABLE DEVELOPMENT

In response to the World Commission on Environment and Economy initiative, Canada adopted as its definition of sustainable development (Canada 1987a):

> the utilization of resources and the environment to optimize economic and other societal benefits today while not damaging prospects for their use by future generations.

At the provincial level, the British Columbia Task Force on Environment and the Economy recommended that a provincial round table on economy and the environment be established and that it should conduct special studies on matters of interest to the round table (B.C. Task Force 1989: 2).

This report considers selected aspects of the current water planning and management system in British Columbia. It examines the B.C. Water Act and associated institutional arrangements for water management. Related legislation, allocation processes, and other resource management agencies which affect water allocation decisions are also reviewed. Finally, it makes some recommendations to move the province toward sustainability in water and water-related resource management.

WATER MANAGEMENT AND SUSTAINABILITY

Water is a fundamental component of the British Columbia resource base, and is interconnected in all phases of the hydrological cycle: atmospheric, surface, groundwater, and ice. It is essential in suitable quantities for all life forms. It is used for a variety of instream nonconsumptive uses such as navigation, fish, wildlife, recreation, and tourism. And there are a variety of other water and water-derived services which either withdraw water for consumptive uses such as municipal and industrial purposes, agriculture, or for transformation into energy. Along with topography, water controls or influences the location of most human settlements and infrastructure, and has inspired various artistic and cultural expressions.

When viewed from the perspective of sustainability, all of these water uses and related land management issues are interdependent and often competitive. For example, the decision to permit hydroelectric development often precludes habitat enhancement for some fish species, and certain kinds of recreation, tourism, forestry, agriculture, and wildlife habitat.

Or heavy consumptive uses in a drainage basin for one purpose, such as irrigation, often prevent all later potential consumptive uses as well as impair or destroy the potential for other instream uses including fisheries, wildlife, birds, and some forms of recreation and tourism. And pollution is normally detrimental to all water uses.

Because of the interrelated nature of all water uses and users and various sectors of the economy, there is not a unique solution to the mix of uses which will promote sustainability of all resources within the drainages of the province. Rather, sustainable development is an ideal in which mutually interdependent economic, environmental, and social objectives must be balanced. As society attempts to choose combinations of resource uses which foreclose as few development options for future generations as possible, all the potentially competing and complementary uses within the watersheds and aquifers of this province need to be considered simultaneously. Such an approach, traditionally called integrated resource management, may require major institutional change in British Columbia.

A PERSPECTIVE ON WATER MANAGEMENT IN BRITISH COLUMBIA

There has been little effort devoted to addressing sustainable water management on a comprehensive basis within British Columbia. Rather, certain users and uses have been encouraged over time as new socioeconomic opportunities emerged. In general, there has not been widespread public discussion of social preferences for alternative water and related land uses. However, under the British Columbia Utilities Commission (BCUC), the public is given the opportunity to comment from time to time on major development issues such as the Site C Dam. In future, local communities and the general public must be given increased opportunities to participate in making these decisions (B.C. Task Force, 1989: 16-17).

Initially water was allocated for mining in the gold rush days of the 19th century. Then irrigation, other agricultural, hydroelectricity, municipal, and industrial uses grew. And these uses were supported by legislation. Stated another way, there has been comparatively little attention paid to the needs of instream water uses for fish, wildlife, recreation, and tourism, as well as water quality and the sustainability of provincial aquifers. As a result of this historical sequence of development, many of the later water users are currently at a comparative disadvantage in terms of water allocation, financial, and manpower resources for planning and management, and priority for consideration under existing British Columbia water management law.

Many provincial rivers, particularly in the northern half of the province and those draining the western slopes of the Coast Mountain Range, remain in an essentially pristine condition except for major logging, isolated mining, and other disturbances. They are the natural habitat to rich runs of salmon and other fish species, a diverse flora and fauna, and remote, small, and scattered communities of resource towns, and Indian bands. All of these settlements depend, to varying degrees, on a sustainable natural environment for their existence. In addition, it is the continuation of largely natural processes, landscapes, and undisturbed wilderness which draw growing numbers of British Columbians, North Americans, and tourists from world-wide destinations to the remote corners of the province and sustain tourism as the second major industry in the province.

In view of the large and growing pressures to use the river basins of the province for multiple uses, a reactive, poorly integrated management system has been adopted by both senior levels of government to document the resource base, to establish priorities for its use, and to make trade-offs and resolve conflicts among potential competing users. If it is attempted at all, river basin planning, like most resource planning in the province, is undertaken on a sector-by-sector basis and is weakly integrated within river basin boundaries.

The perspective advanced in this report is that: 1) there is not an inherently correct combination of sustainable water flows, and water-derived products, including energy, for British Columbia; and 2) there is little probability that the current reactive provincial and federal water planning and management systems would produce a socially desirable mix of water and water-derived services. There should be social choices but at present conflicts in resource allocation are often taken behind closed doors. Rather, a new approach is needed to choose appropriate combinations of water and land uses within the river basins of the province.

THE WATER RESOURCE

The current level of intelligence concerning water in British Columbia reflects the historical abundance of the resource. In most areas there have not been prolonged shortages. As a result, little effort has traditionally been devoted to inventorying and managing water other than for specific development projects. Some data bases which do exist are described below.

STREAMFLOW AND SNOW

A jointly funded federal-provincial program is the major source of streamflow information. It consists of almost 600 measuring stations under the direction of the Water Survey of Canada. This network is supplemented by 260 manual snow survey stations and 25 automated stations operated by the B.C. Ministry of Environment and B.C. Hydro. Snow depth and equivalent water amounts are measured monthly from December to May. This is the strongest component of the current water inventory system.

LAKE, RIVER, AND STREAM INVENTORIES

The level of intelligence in these areas is generally inadequate for reliable decision making. Only 300 of 21,000 lakes have been surveyed, mainly in the southern third of the province. Data include physical descriptions, fish present, and productive capability. And roughly 200 rivers and streams of 4000 in the province have been inventoried at reconnaissance level with limited detailed mapping. These surveys are similar to the lake studies with an aquatic habitat component added.

QUALITY

Water quality monitoring is carried out to determine trends in fresh water and groundwater quality. Generally, little detailed information is available on the quantity and quality of groundwater in the province. Surface water quality management is not investigated here.

Acid Rain. This condition is generated by industrial emissions, exhaust from cars and other forms of transportation, ore smelting, natural gas processing, and thermal generation sources (B.C., MOE, 1989). All of these sources make rainfall more acidic than under natural conditions. In heavy concentrations, acid rain can cause esthetic losses, the destruction of forests, fish, tourism, and recreation resources, and the deterioration of building and automobile surfaces. Human health can also be detrimentally affected.

There are comparatively few major acid rain pollution sources in the province. Moreover, the predominant west to east atmospheric movement normally transports such pollutants out of the province. There is a large area in the central part of British Columbia where alkaline lakes and soils are able to chemically neutralize excess acidity from precipitation. However, most of western British Columbia is underlain by granitic bedrock as well as a zone of highly sensitive soils which extend from the southern to the northern border. Both of these areas are highly sensitive to acid precipitation and are also at risk (Technical Committee . . ., 1987: figs. 4-2 and 4-5).

Acid rain has not become a large-scale problem in western Canada and specifically in British Columbia to date (B.C., MOE, 1989: 1). Nevertheless, in an effort to understand and monitor this phenomenon, Environment Canada is operating eight stations and the B.C. Ministry of Environment has additional installations. Data are pooled in an effort to detect and prevent serious acid rain problems before they develop in the province.

WATER DEMAND AND ALLOCATION

As a consequence of the poor quality of information that exists on British Columbia's water resource, the capability to support various resource uses, and water commitments in the streams, rivers, and lakes of the province, allocation decisions must continually be made on the basis of incomplete information. Moreover, the provincial water comptroller is forced by the existing Water Act to react to development proposals. Indeed, the act makes no provision for anticipatory planning of the kind that would consider the implications of allocation decisions on the capability and sustainability of complementary and competitive resources within the watersheds.

The B.C. comptroller of water rights has traditionally used a manual system to keep track of water availability and existing licenses within provincial drainages. As of 1990, this system has resulted in about 5,500 of 25,000 subbasins having a possible or known water shortage. In 1989, a major initiative was undertaken to computerize the existing data for about 40,000 active water licenses in the province as well as available flow data by watershed. By the end of 1990, it is expected that this information will be analyzed for the Kootenay Region.

Similar analyses are expected to be available for the whole province by the end of 1991. It is anticipated that the new system will permit an estimation of the dependable flow available in each subbasin as well as the level of allocation of current water licenses cumulatively and by individual uses. This new information system will give the comptroller a better data base than has previously been available to adjudicate requests for new licenses. Eventually, the new data bases may be linked to a computer mapping system so that the spatial patterns of water allocation, surplus, and deficit can be rapidly estimated within large basins.

THE WATER ALLOCATION SYSTEM

JURISDICTION

In the Canadian federal system, authority over water resources is shared by both federal and provincial governments. The "resources amendment" to the 1982 Constitution Act gives the provinces exclusive jurisdiction over many aspects of nonrenewable natural resources, including water (Percy, 1984: 103). The provinces exercise propriety rights over water resources and, therefore have the authority to legislate on all aspects of water supply, use, pollution control, hydroelectric and non-nuclear power development, irrigation, and recreation (Canada, 1987b: 11).

The federal government is responsible for fisheries, navigation, federal lands, some specific aspects of environmental protection, Indian and northern lands, and interprovincial and international water management. As the provinces delegate authority to local and regional governments, three or sometimes four levels of jurisdiction are involved, to some degree, in managing water resources. There is, therefore, considerable overlap of functions, which often leads to conflicts among the governments (Canada, 1985a). Further, several agencies at each level of government have interests in, and some responsibility for, water planning.

FEDERAL WATER PLANNING POWERS

The constitution provides for exclusive federal jurisdiction over a variety of matters that are related to water management. These include fisheries, navigation, relations with foreign governments, federal lands, aboriginal people, and some others which limit the provinces' authority over water.

In 1970, the federal government attempted to deal more broadly with fresh water planning and management by adopting the Canada Water Act, among others. Part I of the act provides a much broader scope for federal activities than was previously considered by permitting it to enter into agreements with provincial governments for conducting research and water inventories, formulating comprehensive water management plans, and designing and executing projects. Under the act, Environment Canada has worked cooperatively with the B.C. Ministry of Environment (MOE) on a variety of initiatives. These include Okanagan Basin planning and implementation, Fraser River upstream storage planning, Fraser estuary planning, and Thompson Basin preplanning. By far, the most ambitious is the Lower Fraser Valley flood control measures. Recently, a cooperative flood control mapping program has also been initiated.

PROVINCIAL LEGISLATION

The Water Act (1979c) regulates water allocation in the province. It is based on the prior appropriation, or "first in time, first in right" legal doctrine. Allocation is by the licence or permit system. Among other things, the act defines the priority among water users, who can hold a water licence, and its duration.

Recognized Water Uses. Under section 6, the following are eligible for water permits: an owner of land or a mine, holders of a certificate of convenience and necessity from the provincial government, municipalities, districts, and B.C. Hydro.

Duration. Licences are granted for an indefinite period as long as the holder pays the fees, and complies with the terms and conditions of the licence (sect. 20).

Priority. Among users of the same stream, priority is determined by the licensing date. For the same date, the priority, in decreasing order of importance is domestic use and sanitation; fire prevention; municipal; medicinal and high temperature waters; irrigation; mining; industrial; electricity or other forms of power; earth and rock moving; storage; fish and wildlife conservation; conveying water for licensees; and the diversion, impoundment, or drainage of water to protect or develop park land (sect. 12).

Who is excluded. The act is concerned primarily with offstream water use. With the exception of hydroelectric power generation, it does not address instream requirements, nor does it make provision for accommodating other interests. Thus the more recent water uses, such as recreation, tourism, fish, wildlife, and environmental esthetics, were not considered as worthy of water allocation when the act was proclaimed in 1979.

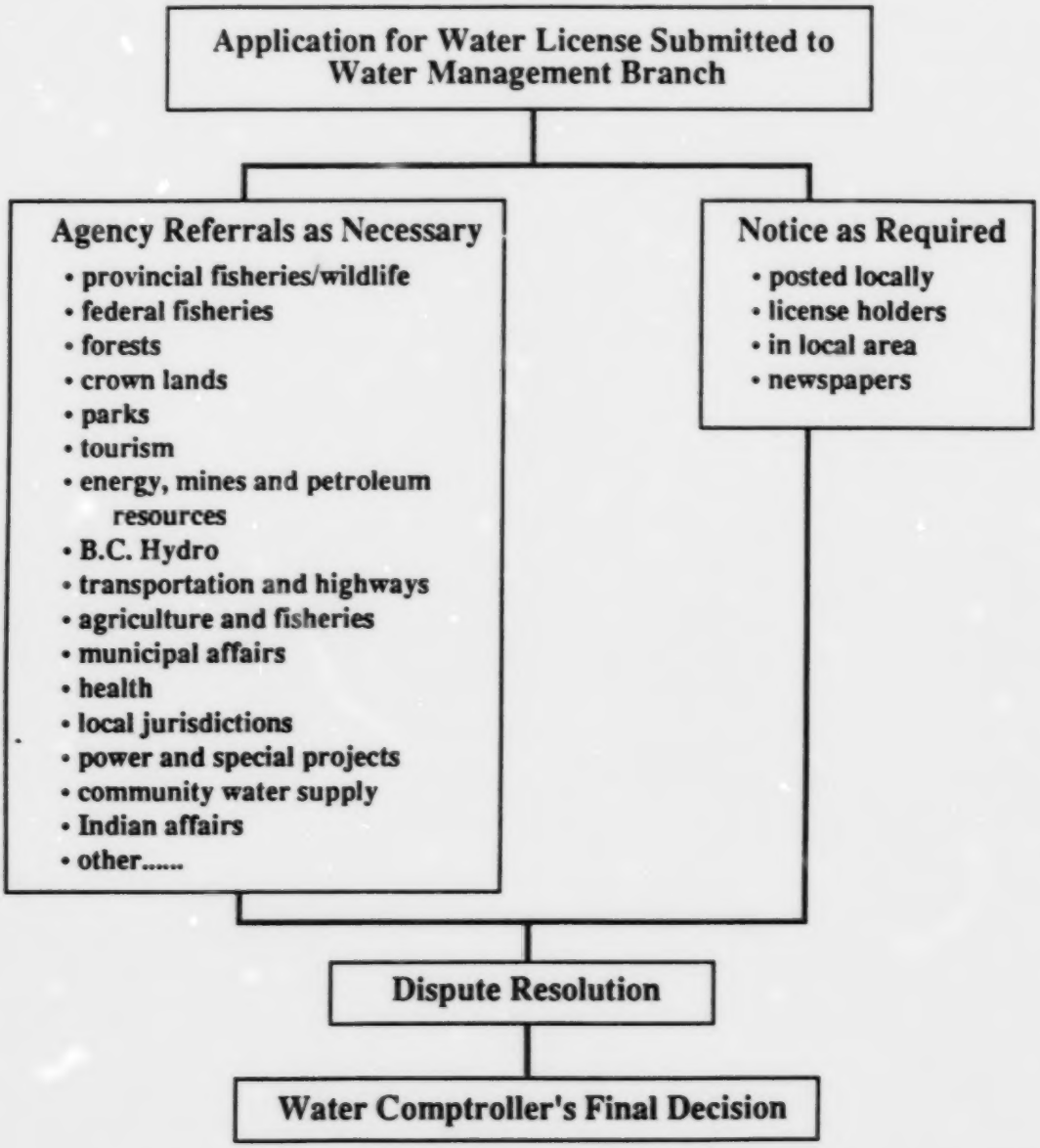
THE PROVINCIAL ALLOCATION PROCESS

Applicants for water licenses submit proposals to the Water Management Branch of the Ministry of Environment. The Water License Administration unit of the branch circulates proposals to interested federal and provincial agencies as well as notifies affected water users both upstream and downstream of the proposed use area (fig. 1). New applications are posted locally and advertised in newspapers if required.

In attempting to resolve objections over requests for water licenses, the comptroller is guided by several criteria. Senior water rights must be protected and sufficient water must

be available most years before additional water allocations can be granted. When criticism is received relating to a request for water, the applicant is put in contact with objectors to determine if a design modification or mitigation measure can resolve the concerns. But in the final analysis, the current Water Act compels the comptroller to issue a license if it is for uses approved in the act. As a consequence, all of the water can be allocated to the approved consumptive uses to the detriment of potential instream requirements for fish, wildlife, recreation, and tourism.

Figure 1. The British Columbia System for Adjudicating Water License Requests.



CONFLICTING MANDATES

There are real and potential conflicts in provincial mandates for water administration and use. For example, the promotion of agrochemicals by the Ministry of Agriculture and Fisheries to increase productivity may be at variance with the Ministry of Environment's goal of environmental protection. Similarly, dam construction to make possible hydroelectricity generation, and clear-cut logging to reduce timber harvesting costs, both may impact negatively on instream uses such as fish habitats, wilderness, and tourism values. To set compatible water management goals, all resource agencies and the private sector must adopt the objective of sustainable development. They must also adapt their water uses to meet new social objectives.

OFFSTREAM WATER AND RELATED LAND AND RESOURCE MANAGEMENT

HYDROELECTRICITY

Hydroelectricity is a cornerstone of the British Columbia economy. Electricity generated from falling water by B.C. Hydro is mainly derived from two drainages. Four dams on the Columbia River system--the Mica, Revelstoke, Seven Mile, and Kootenay Canal--produce on average 22,130 gigawatthours (GWh) annually, or 47.6% of the utility's hydroelectric energy. The Shrum and Peace Canyon dams on the Peace River account for 16,500 GWh, or 35.5%. All other drainages contribute the remaining 7820 GWh, or 16.8% (fig. 2). In total, the province has 9637 MW of dependable capacity, 99.9% of which is derived from hydroelectric generation (B.C. Hydro, 1989a: append. II, p. 13). The authority's revenue in 1988 was $1.7 billion and its net income $25 million.

The Institutional System

Four major actors play important roles in the decision to authorize new hydroelectric projects which have a profound impact on the affected watersheds. These are summarized below.

B.C. Cabinet. The provincial cabinet is directly involved in fundamental policy questions such as prebuilding a large hydroelectric project for energy export, or the desirability of inviting private enterprise firms to develop hydroelectric projects (fig. 3). The ministers of energy, mines and petroleum resources and environment implement cabinet policy on such matters. Three related institutions play a variety of roles in operating the system. The Energy Policy Branch of the ministry of energy, with other provincial bodies, decide how development applications will be handled.

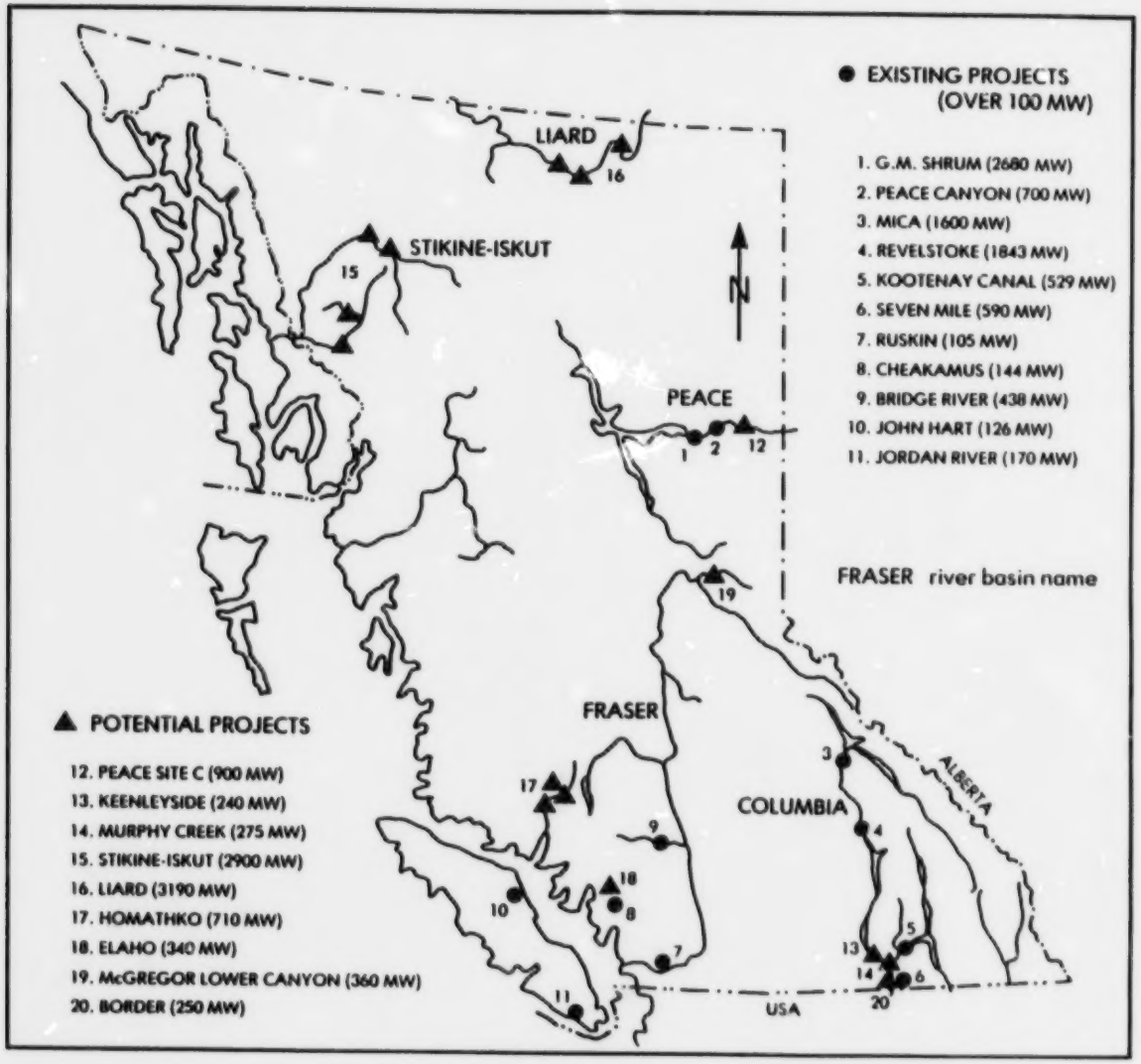
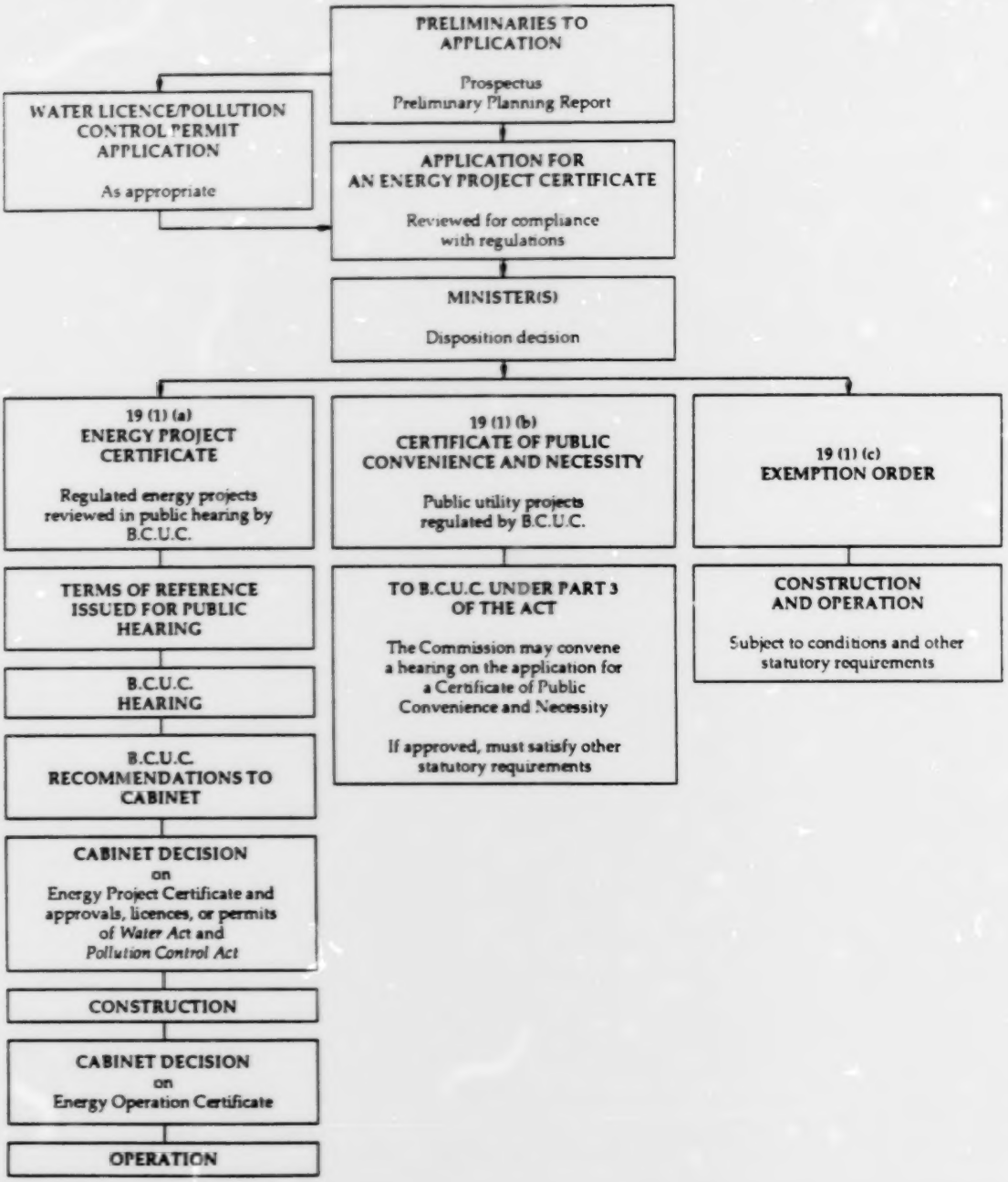

● EXISTING PROJECTS (OVER 100 MW)
1. G.M. SHRUM (2680 MW)
2. PEACE CANYON (700 MW)
3. MICA (1600 MW)
4. REVELSTOKE (1843 MW)
5. KOOTENAY CANAL (529 MW)
6. SEVEN MILE (590 MW)
7. RUSKIN (105 MW)
8. CHEAKAMUS (144 MW)
9. BRIDGE RIVER (438 MW)
10. JOHN HART (126 MW)
11. JORDAN RIVER (170 MW)
FRASER river basin name
▲ POTENTIAL PROJECTS
12. PEACE SITE C (900 MW)
13. KEENLEYSIDE (240 MW)
14. MURPHY CREEK (275 MW)
15. STIKINE-ISKUT (2900 MW)
16. LIARD (3190 MW)
17. HOMATHKO (710 MW)
18. ELAHO (340 MW)
19. McGREGOR LOWER CANYON (360 MW)
20. BORDER (250 MW)
LIARD
STIKINE-ISKUT
PEACE
FRASER
COLUMBIA
ALBERTA
USA
N

Figure 3. The Energy Project Review Process[a].


PRELIMINARIES TO APPLICATION
Prospectus
Preliminary Planning Report
WATER LICENCE/POLLUTION CONTROL PERMIT APPLICATION
As appropriate
APPLICATION FOR AN ENERGY PROJECT CERTIFICATE
Reviewed for compliance with regulations
MINISTER(S)
Disposition decision
19 (1) (a)
ENERGY PROJECT CERTIFICATE
Regulated energy projects reviewed in public hearing by B.C.U.C.
19 (1) (b)
CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY
Public utility projects regulated by B.C.U.C.
19 (1) (c)
EXEMPTION ORDER
TERMS OF REFERENCE ISSUED FOR PUBLIC HEARING
B.C.U.C. HEARING
B.C.U.C. RECOMMENDATIONS TO CABINET
CABINET DECISION
on
Energy Project Certificate and approvals, licences, or permits of Water Act and Pollution Control Act
CONSTRUCTION
CABINET DECISION
on
Energy Operation Certificate
OPERATION
TO B.C.U.C. UNDER PART 3 OF THE ACT
The Commission may convene a hearing on the application for a Certificate of Public Convenience and Necessity
If approved, must satisfy other statutory requirements
CONSTRUCTION AND OPERATION
Subject to conditions and other statutory requirements

[a]From B.C., Energy, Mines and Petroleum Resources, 1982: 7.

British Columbia Utilities Commission. The province adopted an integrated approach to approval procedures for major energy projects and export of energy from the province in the Utilities Commission Act of 1980 (B.C., Revised Statutes 1980). With revisions, it remains in effect today. Under certain circumstances, under the act, the province retained the power to review and certify the construction and operation of major energy projects. The act provides for the regulation of public utilities, including B.C. Hydro, by the British Columbia Utilities Commission (BCUC). The commission reviews and certifies projects which generate, use, store, transmit, or export large quantities of energy. BCUC may also rule not only on a project but also on whether approval should be granted under the Waste Management Act and the Water Act at the same time (*Ibid.* s.20(1)(2)a). A fundamental characteristic of the British Columbia regulatory regime is the strong discretionary control which the provincial government retains over the entire process (Barton 1987: 61).

Over ten years of operation, the B.C. Utilities Commission has emerged as a fair and impartial forum in which a broad range of questions concerning the social utility of proposed energy projects can be publicly reviewed. Although the answers received from such an institution depend largely on the values and political independence of its members, to date the commission's effectiveness and impartiality from government influence can not be questioned. It is important to note in this regard that the government retains control over the selection of the chairman and commissioners for such reviews. The major constraint on BCUC hearings is the range of questions it is asked to address by the provincial government.

In the Site C reference, the value of an independent assessment of B.C. Hydro's proposed projects was clearly established. Although the commission is commonly criticized for taking too long to reach a decision, and for conducting reviews which are too costly, it has already saved the province hundreds of millions of dollars in unnecessary interest payments. In addition, electricity rates are lower today for all consumers than would have been experienced had the commission not rejected the $3.2 billion Site C dam proposed by B.C. Hydro in 1983.

B.C. Hydro. The final actor is the British Columbia Hydro and Power Authority. Among other things, the utility plans, constructs, and operates hydroelectric projects for the province. It was given a broad mandate to carry out policies of the provincial cabinet under the Hydro and Power Authority Act (B.C., Revised Statutes, 1979a). There are few restrictions on the powers of the authority (sects. 12, 16, 41, 42). However, the province

regulates it, by making statutory provisions of other provincial acts applicable to the authority. These include the Environment Management Act, the Heritage Conservation Act, the Utilities Commission Act, the Water Act, and the Waste Management Act (sect. 52(5)). Its subsidiary company, POWEREX, markets power and energy to the United States. The interrelationship of these bodies is described more fully below.

Application Procedures

An application for an energy certificate under section 18 of the Utilities Commission Act is made to the minister of Energy, Mines and Petroleum Resources. At the same time, applications for a water permit are submitted to the Water Management Branch of the Ministry of Environment (B.C., 1979b) (fig. 3).

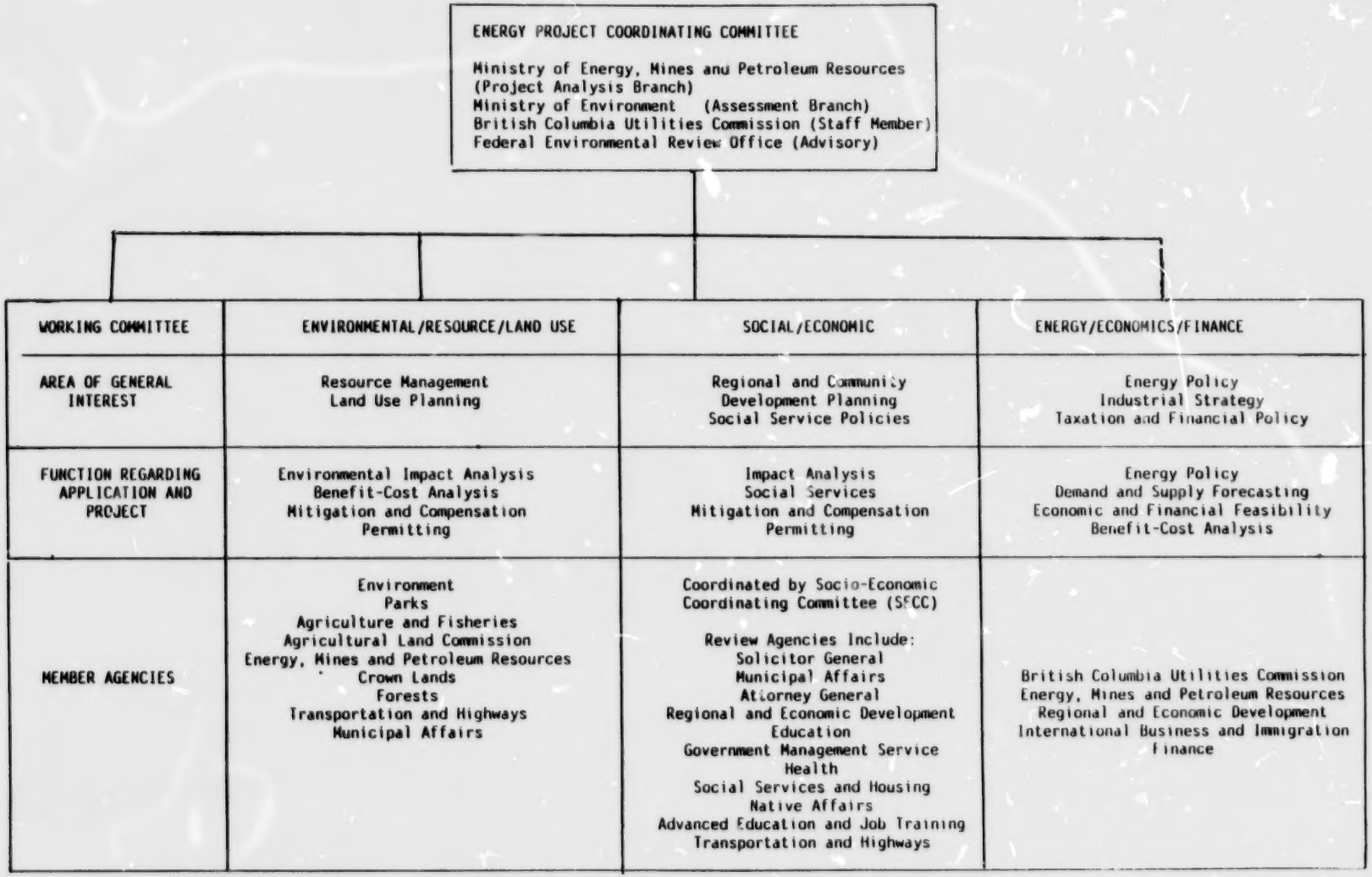
Provincial Review

A comprehensive referral process has been established by the provincial government to coordinate the work of all agencies involved in the review of preliminary studies and applications (fig. 4). This process is currently being revised. The key agency in the evaluation of regulated projects is the Energy Project Coordinating Committee (EPCC). It is composed of representatives from the ministries of energy, environment, and the utilities commission. Not included in the committee are tourism, fisheries, forestry, agriculture, and municipalities. This body coordinates reviews and advises the ministers. Although federal agencies have not normally been involved in these proceedings, mechanisms are currently being created to facilitate this integration.

Working Committees. Three additional bodies coordinate provincial concerns related to environment, resource, and land use issues; social and economic matters; and energy and financial questions (fig. 4). The committees were seldom used during the 1980s because of a provincial surplus of electricity and the lack of interest in new energy projects. During 1989 these committees were called on frequently in the review of private power proposals.

Permission to use water for hydroelectric generation is obtained by license issued under the Water Act (B.C., 1979c) by the comptroller of water rights of the Ministry of Environment. In the past, the comptroller notified all persons whose rights, or water license, would be affected by a request for a new license (B.C., 1988: sects. 32, 33).

Figure 4. Interagency Framework for Energy Project Review.[a]


ENERGY PROJECT COORDINATING COMMITTEE
Ministry of Energy, Mines and Petroleum Resources (Project Analysis Branch)
Ministry of Environment (Assessment Branch)
British Columbia Utilities Commission (Staff Member)
Federal Environmental Review Office (Advisory)

WORKING COMMITTEE	ENVIRONMENTAL/RESOURCE/LAND USE	SOCIAL/ECONOMIC	ENERGY/ECONOMICS/FINANCE
AREA OF GENERAL INTEREST	Resource Management Land Use Planning	Regional and Community Development Planning Social Service Policies	Energy Policy Industrial Strategy Taxation and Financial Policy
FUNCTION REGARDING APPLICATION AND PROJECT	Environmental Impact Analysis Benefit-Cost Analysis Mitigation and Compensation Permitting	Impact Analysis Social Services Mitigation and Compensation Permitting	Energy Policy Demand and Supply Forecasting Economic and Financial Feasibility Benefit-Cost Analysis
MEMBER AGENCIES	Environment Parks Agriculture and Fisheries Agricultural Land Commission Energy, Mines and Petroleum Resources Crown Lands Forests Transportation and Highways Municipal Affairs	Coordinated by Socio-Economic Coordinating Committee (SECC) Review Agencies Include: Solicitor General Municipal Affairs Attorney General Regional and Economic Development Education Government Management Service Health Social Services and Housing Native Affairs Advanced Education and Job Training Transportation and Highways	British Columbia Utilities Commission Energy, Mines and Petroleum Resources Regional and Economic Development International Business and Immigration Finance

[a]From: B.C., Energy, Mines and Petroleum Resources 1982:11.

New procedures are currently being formulated to allow all interested government agencies to also comment on such applications.

The issuance of water licenses is profitable for the Province of British Columbia. For example, in the 1988/1989 fiscal year, fees from all water licenses were $247 million. Of this, more than $244 million were from major power producers.

Environmental and Social Impacts of Hydroelectricity Development

A great variety of interests are directly or indirectly affected when a new dam blocks the flow of a river. The hydroelectricity produced is environmentally clean compared to hydrocarbon and nuclear energy sources. But a variety of other effects, mainly negative, are induced and most of these are experienced in the project area. Some of the most common of these, as described in the Site C Report (BCUC 1983) and other sources (Baxter and Glaude 1980), are summarized below.

Land Use and Environmental Effects. Based on 1986 estimates, the Site C Project would affect 6000 ha, 4600 ha of which would be flooded. Of this, 3000 ha are agricultural land with a social value of $59.8 million calculated at an 8% discount rate (B.C. Legislation Assembly, 1981). In addition, 1700 ha of forestry land would also be inundated with a social loss of less than $1 million. Traditionally, the timber in reservoirs is lost to drowning although it would be cleared in the case of the Site C dam. River-based recreation losses are estimated at $6.9 million; game and nongame wildlife losses are $2.8 million. The economic effect on recreational fishery could not be estimated because of insufficient data.

There could be significant climatic changes in the vicinity of the reservoir including increased fog and humidity which might adversely affect farming and transportation. In addition, earthquakes are often induced in regions with well-developed faulting systems where loading associated with the weight of a new dam and accumulated water can cause crustal instability and in some cases movement (U.S. National Academy of Sciences 1972).

Water quality is often degraded downstream of a new dam as a result of the effect of construction activities. This can have a detrimental effect on downstream water users and degrade fish habitat. Mercury methylation now appears to be ubiquitous in newly created

reservoirs. Prolonged submergence of soils and vegetation causes bioaccumulation of mercury in the organisms of an affected food chain. This often causes the level of mercury in predatory fish species to exceed the safe level for human consumption. In special circumstances where hydroelectricity generation is based in whole, or in part, on water directed from one drainage to another, artificial diversion channels can permit the passage of unwanted fish species, diseases, and parasites to the detriment of indigenous fauna and flora. In addition, reservoir instability may be induced in reservoir and stream banks where changes in soil moisture content can cause slumping. In areas of natural instability, there could be severe anthropogenic hazards if large landslides enter reservoirs and cause tidal waves above and below a dam.

Heritage and mineral resources are often lost due to inundation. Although field surveys and recovery programs are possible to remove valuable artifacts and mineral deposits prior to inundation, adequate archaeological surveys are seldom conducted.

Regional Economic and Social Impacts. A major positive short-term effect of new dams is the substantial amount of work created over a prolonged period in the project area. In the Site C case, 5400 person years of employment are anticipated over 7-years. Depending on the share of work given to regional residents, this can account for the major positive benefit of such an undertaking in offsetting the biophysical disruption, losses, and social inconvenience. To ensure that potential local benefits are maximized, aggressive long-term training programs for local residents and Indian band members are necessary long before construction begins, as has been practiced in Quebec and Manitoba (Day and Quinn, 1991). There must also be a commitment by the hydro authority to train local residents to operate and maintain the project when it is completed

Local communities which must house the itinerant component of the construction work force often experience increased costs for water, sewage, schools, and the provision of other services. But the major social impacts are felt by the families who lose their homes, land, and livelihoods. Native bands who practice a subsistence lifestyle are particularly vulnerable to the negative effects of damming, particularly if there are other major disturbances related to settlements, transportation, or industrialization in that area.

Traditionally, hydroelectric authorities have concentrated on generating and distributing electricity from dam projects: there has been little or no effort to ameliorate negative effects. Increasingly, the wide range of negative biophysical and social impacts associated

with new hydroelectric projects is being recognized. Compensation, mitigation, and monitoring are being undertaken to correct these problems to the extent possible. Currently, it is recommended that monitoring be carried out by an independent commissioner with a small staff and the authority to issue orders to the hydro authority, liaise closely with government agencies, and be accessible to the affected publics (BCUC, 1983).

Electricity Futures. Sustainability and river basin management are closely interrelated. In an undisturbed state, rivers provide sustainable habitats for fish and wildlife. They also contribute to the enchantment and mystique of the province for millions of visitors in search of an experience in undisturbed landscapes. As industrialization inexorably occurs to satisfy a variety of legitimate needs, the sustainability of various symbiotic natural resource processes has historically been systematically diminished. The process of river damming is one of the most ecologically disruptive forms of industrialization in operation today. For this reason, careful proactive planning is needed to ensure that socially acceptable decisions are taken concerning the future use of the provincial rivers.

To the present time, hydroelectric disturbance of the major provincial river systems has been largely restricted to river basins in the southern half of the province. Fortunately, many major river systems, or large tributaries, remain in a free-flowing condition. However, the province has never held public forums to make people aware of the variety of resource values available in the provincial river systems. Nor have the diverse array of affected interest groups been given the opportunity to comment publicly on their preferences for future river development options for energy or other uses.

B.C. Hydro recently prepared a twenty-year plan of its preferred development options, and a tentative sequence of projects (B.C. Hydro 1989a: 41-45). Under the hydroelectric scenario, none of the major provincial drainages would be spared over the long term in this vision. Indeed, if past practice were to continue, there is a real danger that all of the major basins in the province could be successively dammed for electricity without ever holding public hearings on the implications of potential cumulative development options for a sustainable provincial economy.

Over the following year B.C. Hydro adopted an entirely different and progressive energy development policy (B.C. Hydro, 1990). Its new strategy is to minimize adverse natural,

social, and environment impacts in the process of generating and supplying electricity efficiently. Given this new perspective, its supply priorities were dramatically altered. Increased efficiency of energy use and existing energy generation facilities and coordination of operations with other utilities and companies became the preferred development options. These were followed by small hydro projects, wood waste, fuel cells, and gas. Of much lower importance were large hydroelectricity options on the Peace and Columbia systems, and finally the undeveloped basins of the province, among others. As a result of this shift in emphasis, the river basins of the province were given a short-term reprieve. This time should be used to investigate the opportunities and needs for sustaining other potential water users in the province.

FORESTRY

The forest ecosystem supports the resource base necessary for the development and growth of a variety of water and forest-based activities and industries. Forestry resources have traditionally been, and continue to be, fundamental to the British Columbia economy. The Ministry of Forests is empowered by the Forest Act to allocate timber, and to manage provincial forests, which constitute about 85% of the area of the province (B.C., 1987a). The act also empowers the Forest Service to manage forest and range resources in a way that would enhance the development of related natural resources, including water. Through its integrated resources management program, the ministry works with other agencies, resource industries, and the general public in setting management guidelines and standards (*ibid.*).

However, some forestry management practices, including road construction, logging, slash-burning, and other postlogging operations, have serious environmental impacts. Water quality and timing of flow, soil erosion, fish and wildlife production, habitat protection, and environmental esthetics can all be negatively affected by forest management. Such effects have generally been considered social development costs. But with the growing public concern over environmental protection and ecologically sound forest management practices, such an accommodating view may not always prevail.

Research suggests that there is a strong and predictable inverse relationship between vegetative cover and water yield. World-wide catchment experiments monitored in the USA show that in clear-cuts of over 10 hectares, a 10% reduction in forest cover causes about 25 to 40 mm increase in mean annual water yield in deciduous hardwoods and conifers respectfully (Bosch and Hewlett, 1982). The study also showed that there is no

noticeable hydrologic response to logging if a clear-cut is less than 20% of a forested watershed.

A preliminary B.C. Ministry of Forests study in the Penticton area also shows that when 30% of the forested area is clear-cut, there is a significant effect on water yield (B.C. Forestry Association and Okanagan-Similkameen Park Society, 1989). Total water yield increased by 21%, and the annual peak flow occurred 13 days earlier. This increase in yield and timing may not be desirable, especially in the dry interior. High flow rates could lead to water quality degradation; and early runoff reduces groundwater recharge and makes water less available later.

In an effort to reconcile the needs of forestry with those of other officially recognized water resource uses, the ministry is developing watershed sensitivity rating guidelines for coastal watersheds (B.C., 1987b). In studying the effects of logging practices on a watershed, the ministry is attempting to establish some relationships among water-based resources. Where there are observed detrimental effects, the ministry can determine the capability of a watershed to recover from the degradation, and then attempt to alter harvesting strategies.

If forestry practices are to better protect the integrity of water and related resource uses, new management strategies are required. These include:

a. placing greater emphasis on integrated resources management. There should be greater cooperation among the Forest Service and other agencies, particularly MOE, in resource management programs;
b. developing guidelines on the use of conflict resolution in resource allocation, in cooperation with other resource users;
c. collaborating in research with academic and other research institutions, to establish the effect of various forest management practices on watershed protection, water quality and quantity, esthetics, and fisheries and wildlife habitat;
d. determining the time span before the hydrology of a logged area returns to the condition of an undisturbed forest; and
e. promoting early public involvement in managing emerging issues such as determining the trade-off between logging and wilderness preservation.

It is expected that the B.C. Forest Resources Commission will make recommendations in all of these areas.

MINING

Historically, mining for coal and base metals has had a detrimental impact on water quality and instream uses such as fisheries, recreation, and tourism. In extreme cases, degradation has been so severe that other uses were totally precluded long after the mines have closed. With the adoption of the coal and metal mine review processes in the 1970s and subsequent regulatory improvements, however, the detrimental water-quality impacts of this industry have progressively been controlled. However, the legacy of inadequate control and enforcement of permits in the past will continue into the foreseeable future. Currently, water licenses receive close scrutiny and the threat to surface water is clearly recognized, especially from acid mine drainage. The current initiative to adopt provincial legislation to cover all aspects of the mine approval process, including exploration will further strengthen water quality protection.

A continuing source of conflict has been the negative effects of mine development on community watersheds. Forestry-related complaints are also commonplace in these areas. A coordinated initiative is currently being developed which will ensure more sensitive mining policies for application in the more than 300 designated community watersheds in the province (B.C., 1990a; B.C., 1990b: 18;). Under the new policy, it is intended that all resource developments in these areas must conform to integrated watershed management plans which will be prepared by the Ministry of Environment and the Ministry of Forests. However, only three such plans have been finalized, and 8 are nearing completion. Approximately 40 other community watersheds require plans but these have not been started.

From the perspective of the mining industry, the major water management problem which has been experienced is the excessive length of time which is sometimes required for a decision on a request for a water license from the Ministry of Environment. This reflects the obsolete data management system and low staffing levels in the Water Management Branch. It is expected that the new data management system being developed will help shorten the time required to receive a water license in future, although the number of personnel available to do the work remains a problem. Understandably, companies become anxious when delays occur because of the high cost of establishing a new mine.

However, a mine has never been refused in the province on the basis of water shortage, and interim licenses have been used effectively to bridge the gap.

In summary, lack of regulations and enforcements in mining have traditionally had a detrimental impact on water quality. The introduction of regulations over the past fifteen years has progressively brought this industry under tighter control, and reduced the risk of future environmental impairment. However, sensitive resource management practices have been difficult to achieve in the community watersheds on crown lands in British Columbia. The major complaints have been associated with mining and forestry operations. This area of integrated water and land management requires a substantially greater level of personnel if sustainable environmental quality acceptable to local residents is to be achieved.

AGRICULTURE

Agriculture is an important water user in British Columbia. In 1988, for example, of 900,000 hectares (ha) cultivated, about 12% (110,000 ha) were irrigated. Of this, 40% was supported by storage water. Agricultural water licenses returned $740,000 to the province and the industry accounts for 14% of the provincial gross domestic product (B.C., 1989b).

The goal of agricultural water management is to remove water-related constraints to crop and animal production. Emphasis, therefore, is on irrigation, drainage, livestock watering, and soil erosion control (Canada, 1990: 22). Agriculture in British Columbia is diverse, and is an important socioeconomic activity in the southern interior, and to a lesser extent in the lower mainland. In the former, irrigation is critical because the region is semiarid, with less than 35 mm annual precipitation. HOwever, irrigation reduces late season streamflow needed for other uses. Thus agricultural production in such areas is limited by inadequate water resources. Conversely, in the lowlands of the south coastal region, such as Boundary Bay, the constraint is excessive water in the root zone. Here, drainage is the major concern.

Modern agriculture is intensive, requiring massive use of agrochemicals. It involves the application of fertilizers to supplement plant nutrition; organic and inorganic amendments to improve soil quality; and biocides to control weeds, insects, and other pests. These practices, important as they are in increasing agricultural production, may be major sources of water pollution.

Anthropogenic water pollution is caused by both point as well as nonpoint sources. Runoff and seepage from farmlands are often high in chemicals, and threaten surface and groundwater quality (CAST, 1985). Nitrogen, and other plant nutrients often cause lake eutrophication, and reduce the capability of the water resource to serve municipal, fisheries, recreational, and other uses (O'Riordan, 1976). In humid regions, contamination is low because of large quantities of rainfall relative to the chemicals. In dry regions, the natural precipitation is supplemented by irrigation water, which invariably contains dissolved salts.

Inorganic soil additives include liming materials that reduce soil acidity, acidifying materials to increase the acidity of alkaline soils, and gypsum which increases the entry rate of water in sodic soils. Organic matter includes soil residues, food processing wastes, animal manures, and sewage sludges. They are valuable in agriculture as soil conditioners and fertilizers. The principal concerns about the possible effects of these additives on water quality are the excessive levels of nitrogen associated with outdoor animal feeding operations, and bacterial contamination.

The Pesticide Control Act, and the Waste Management Act regulate the storage, transport, application, and disposal of pesticides and discharge of toxic chemicals. However, this legislation is inadequate in dealing with other agricultural activities which may negatively impact on water quality. Although the Pesticide Control Act proscribes direct pollution from farm activities, it does not address indirect pollution from, for example, seepage and runoff.

The British Columbia Ministry of Agriculture and Fisheries is aware of the need for a more sophisticated approach to water planning and management for agriculture and other water uses in the province. It is in the process of establishing a code of practice which would specify acceptable on-farm water management policies. Committees representing the agricultural community would also be created to adjudicate water-related complaints directed at the agricultural community. While such a regulating body would be a useful innovation to promote education and settle disputes, it should not delay rapid regulatory action by the Ministry of Environment if persistent or serious water quality and or quantity problems are involved.

Allocation of water among agriculture and other uses, and protection of water quality from farm practices, are important water management issues. For sustainable water and related land management, the following are required:

a. more restrictive provincial legislation and stricter codes on manure, herbicide, fertilizer, and other chemical applications;
b. guidelines and regulations on the transport and storage of agricultural chemicals;
c. increased reliance on integrated pest management to reduce agricultural biocide applications;
d. more research on the fate of agrochemicals in the environment, particularly in soil and water; and
e. better insight into the relationship among agrochemicals, water quality, and human health.

OTHER INSTREAM USES

Fisheries and wildlife populations and habitats depend heavily on a functional water system. However, their officially recognized water requirements have only been incidental to other uses. This is largely because in the province's pioneer days, emphasis was on accelerated economic development. As most of the economic activities were related to offstream water use, instream uses, with the exception of hydroelectricity, were not recognized as worthy of protection.

The public is becoming increasingly concerned with other water-related values, such as esthetics and recreation, and is calling for diversification of the economy. Thus it is necessary that, in addition to the conventional economic tools, nonmarket criteria be used in valuing natural resources. New social preferences, and the maintenance of biological diversity, are emerging criteria which, if adopted, could give greater protection to neglected instream uses.

FISHERIES

Commercial and recreational freshwater fisheries make a significant contribution to the B.C. economy. This sector also plays an important role in supporting native lifestyles. Rivers, streams, lakes, and other water systems on which fish depend for their life processes form an integral part of fisheries habitat. Consequently, it is important that remaining habitat should be protected from destruction or degradation, or even enhanced, because of its importance to the provincial economy.

Fish habitats are susceptible to harm from a variety of sources including direct discharges from industrial, municipal, and agricultural effluents, forestry, mining, transportation corridors, as well as construction work in riparian habitats (Canada, 1985). Acid rain and other airborne pollutants can also threaten fish habitats (*ibid.*).

Fisheries-related legislation is multi-jurisdictional, involving provincial, national, and international concerns. Fish in coastal and inland waters are a federal responsibility, but come under provincial jurisdiction when taken out of the water. Because some commercially important fish, such as salmon and rainbow trout, spend part of their lifecycle in the ocean, water management for fisheries has international implications as well. Because of poor data on historical fisheries runs and catch levels, it is impossible to specify with any precision what impact water and land management practices, such as mining, agriculture, urbanization, hydroelectricity, and other influences have had on fisheries.

The B.C. Water Act does not explicitly mention fisheries requirements in water allocation, but specialized water structures and diversions, which are prerequisites for water to be allocated for fisheries, are permitted (sect. 12(1); 1). As well, the Ministry of Forests Act, and the Environment Management Act, have provisions for fish habitat protection (B.C., 1990b). Further, MOE, by special agreement with the federal government under the Fisheries Act, is responsible for the management of resident and anadromous fish in the province. The ministry is to safeguard fish habitat by maintaining required streamflows, protecting water quality, and preserving riparian vegetation and rearing habitats (B.C., 1989b).

There are comparatively few water allocations which benefit fish such as in the Adams River (B.C. 1919). In this instance, the water license had to be issued "in the public interest" because the fish habitat which is protected could not be preserved under existing legislation. And in spite of frequent references to an agreement which prevents the construction of dams on the main stem of the Fraser River in order to protect fish populations, it could not be located for inclusion in this report.

Clearly, fisheries have traditionally received, and continue to receive low priority under the provincial Water Act. They need better protection, which could be facilitated by:

i. amending the Water Act to recognize instream flows as a beneficial use;

ii. regulating the timing of water flow to benefit other water users to the extent possible;
iii. protecting instream flows prior to licensing for other uses when fish are an important component of the ecosystem; and
iv. ensuring water quality--sediment load and chemical composition--especially in water systems important for fish migration, feeding, and spawning.

WILDLIFE

The aquatic environment which includes wetlands, estuaries, water and related vegetation, is important for wildlife. Wetlands are permanently or seasonally wet areas, shallow waters, lakes, river, estuarine, and coastal margins (Canada, 1987b: 26). They are the interface between land and water ecosystems, and provide substantial ecological, economic, and social benefits to both the provinces and the nation.

Wetlands are among the most productive ecosystems, providing essential habitats for waterfowl, fish, furbearers, and about a third of the wildlife species identified as endangered, threatened, or vulnerable (Canada, 1990: 31). They also support commercial and sport fishing, waterfowl hunting, trapping, recreation, water purification, groundwater discharge, and flood-peak modification (Canada, 1987b: 26). Their social benefits include recreational, educational, scientific, and esthetic values. The condition of a wetland is often an indicator of the state of the environment.

Wildlife populations and habitats have declined in the past decades (B.C. Waterfowl, 1989: 18). Drainage, and land use conversion of wetlands to agricultural, urban, and port developments, have all contributed to the depletion of the province's wetlands (Canada, 1987b). An active conservation program is essential if the provincial wetland resource is to play a meaningful role in the sustainability of wildlife populations.

Wetlands which serve as habitats for migratory birds are under joint federal and provincial jurisdiction. Migratory birds in Canada are protected by the Migratory Birds Convention Act of 1916 (British Columbia Waterfowl Technical Committee, 1989: 2), and are further protected in the province by the B.C. Wildlife Act of 1982. Currently, waterfowl are managed jointly by the Canadian Wildlife Service, B.C. Ministry of Environment, and Ducks Unlimited Canada (Canada, 1990; British Columbia Waterfowl Technical Committee, 1989).

In view of the social, economic, and ecological significance of these aquatic ecosystems, wetland conservation should be enhanced by:

a. supporting a level of wintering population of all wildlife species which would ensure viable populations;
b. improving cooperation among MOE and other agencies whose mandates influence the existence and viability of wetlands;
c. minimizing the negative impact of policies, programs, and new developments on wetlands by leaving environmentally sensitive areas undisturbed and implementing mitigation and compensation meansures where necessary;
d. legislating wildlife habitat protection;
e. classifying habitats according to species use, and threat, and encouraging integrated water and related land use practices; and
f. educating the public on wetland values, and involving them in management and conservation programs.

TOURISM

One of the new water uses which is inadequately represented in water and related land planning and management in British Columbia is tourism. Wilderness-oriented adventure tourism contributes $135 million to the $3 billion tourism industry in the province, and it is growing rapidly. Tourism largely depends on a pristine, unpolluted environment, and if it is to continue to attract visitors, then water is an important component of the milieu which must be sustained. Currently wilderness is not deemed to be sufficiently important to warrant a water license. Indeed, it is not mentioned in the Water Act (B.C., 1979c).

The Planning and Resource Management Branch of the B.C. Ministry of Tourism has three basic tasks. In the policy area it is required to review provincial policies related to federal-provincial initiatives, transportation issues, industrial sectors, and of all resource management agencies that affect tourism. It is also charged with the development of provincial tourism policy. In the field of resource management its mandate is to identify and represent the interests of the tourism industry in all significant resource management decisions in the province. At the planning level its task is to identify tourism development opportunities based on existing and potential market demand. Water planning is an important component of all three areas of concern.

RECREATION

The Canadian Heritage River system is a joint federal-provincial initiative that has been adopted across most of Canada. Its purpose is to protect nationally significant rivers from development. At the present time, only Alberta and British Columbia have not joined, although Alberta may do so in the near future. The Outdoor Recreation Council of British Columbia (ORC) has repeatedly urged the province to become an active participant in this program but without success (ORC 1989a: C.4.1., p. 30).

In September 1984 the then minister of lands, parks and housing announced a provincial recreation corridor program. Of 21 water-based candidate corridors nominated for inclusion in the system since that time, four small drainages have been approved, 2 partially approved, 1 has been nominated for inclusion, and 6 are being considered (ORC, 1989b: 2). The Ministry of Parks has been successful in obtaining designation status for recreation corridors.

A single coordinator within a ministry is required if the impressive water-based recreation potentials of the province are to be realized. This person could coordinate the actions of an advisory committee composed of appropriate agencies and nongovernmental organizations to make the process of designating new corridors more effective. The Ministry of Parks or Tourism could be the logical agency to take the lead.

WASTE MANAGEMENT AND WATER QUALITY

Lakes and rivers traditionally have been regarded as repositories for wastes and pollutants. This is because of the capacity of the water system to assimilate wastes by dilution, by carrying them away from discharge points, and by biochemical processes that break down waste (Canada, 1985b: III-7).

Although there have been significant waste treatment improvements before discharge into natural systems in recent years, the increase in the number of pollution sources has often negated a corresponding improvement in water quality. The Lower Fraser River is such an example (Canada, B.C., and FREMP, 1988).

Pollution is more prevalent in heavily populated areas, and where there is a concentration of industries. Fish productivity in such areas is low (*ibid.*). Fish species respond differently to water pollution, but when contaminated with dangerous levels of mercury, dioxins, PCBs, and sewage, and other wastes, they may be unfit for human consumption. The

affected area may be closed to fishing. Pulp and paper wastes, mine tailings and drainage, industrial effluents, and human sewage may all contribute to this problem in the absence of proper treatment.

Water quantity and quality legislation have been developed, but operate independently of each other in the province. There are separate units for water allocation and water quality evaluation in the Water Management Branch, and in the Municipal Liquid and Industrial Waste Branch for checking on permit compliance in the Environmental Protection Division. These are all units of the B.C. Ministry of Environment. It is uncertain if this separation of functions creates problems for water managers and users. Clearly, allocation priorities should reflect water quality, and conversely, water uses should not be licensed without considering the impact on water quality.

Traditionally water quality permits were often not effectively enforced during the 1980s in the province. Brown and Rankin (1989), for example, reported that the Waste Management Branch relied on negotiation and bargaining to achieve compliance with permit conditions. This consensual compliance strategy failed to persuade habitual violators to stop polluting. Prosecution, the sanction of last resort, proved to be equally ineffective with 9 convictions in 1986 resulting in average fines of $500. At the same time, water quality and permit data, the level of compliance, and enforcement actions were withheld from the public.

This extreme level of secrecy began to be removed in July 1990. Recently, the Minister of Environment released a list of 116 industrial operations and municipalities out of a total of about 3050 permits in the province, which were either not complying with their waste management permits or were considered to be a potential pollution concern (B.C., MOE, 1990a). Only a terse description was provided of the nature of noncompliance, but further data are available from the appropriate regional office concerning details of pollution permits and current effluent characteristics. Such data, which have been routinely available to citizens of Washington State for more than a decade, have assisted public interest groups to focus attention on persistent polluters. Supported by increased staff and funding, the Ministry of Environment intends to increase the level compliance with existing permits in the future.

NATIVE USES

Water is central to the spiritual, cultural, and economic existence of aboriginal peoples. It is an important source of food and income because water and associated land and vegetation provide habitat for fish, waterfowl, game, and fur-bearing animals. It is also an important mode of transportation.

Urban and industrial developments have negatively impacted on aboriginal lifestyles. By changing the quantity, quality, and distribution of water and related resources, development projects have altered the hunting, trapping, and fishing patterns of native people. As a consequence, there has been an increase in the incidence and intensity of native peoples' protests over water and land claims in the attempt to regain control over their traditional territories.

The affirmation of native peoples' rights to water and related resources would demand an accommodation of aboriginal interests in resource management. This could be facilitated by:

a. settling aboriginal land claims. Protecting native rights to water in B.C. must be considered in the wider national context, because native issues are mostly under federal jurisdiction. However, there are special federal-provincial constitutional agreements on aboriginal issues. The recent Yukon Land Claims Settlement, and other court decisions (Bartlett, 1988) have affirmed the unique status of aboriginal water rights; and by
b. legislating the role of aboriginal people in the planning and management of water resources where they are stakeholders.

GROUNDWATER

Groundwater quantity and quality are largely a function of land and water use practices. Industrial actions in forestry and agriculture as well as urbanization, industrialization, and waste disposal practices all affect groundwater. Fortunately, there are currently no major areas of groundwater mining in the province.

In terms of management, the B.C. Water Act does not permit licensing of either groundwater quantity or quality. Generally, this has not been a problem as the well drilling profession has voluntarily provided information on roughly 50,000 wells throughout the province. In addition, 750 water well location maps, and 360 groundwater quality overlay

maps showing well locations with water quality analyses, are on file. A network of 145 observation wells is currently being maintained in the province to monitor changes in water levels and trends in quality. These are primarily located in areas where groundwater is used extensively for potable water supplies and irrigation purposes.

In the United States it is estimated that 2.7 to 6% of the rural water supplies in the nation are contaminated by nitrate. This can cause a life threatening condition in infants and it is suspected of causing cancers in adults as well. Pesticides are also a groundwater problem in some agricultural areas (Freshwater Foundation, 1986 and 1988). The long-term result of the coexistence of nitrates, pesticides, and other chemicals is unknown.

The major British Columbia groundwater problem at present relates to quality degradation. Although only sketchy data are currently available, the level of nitrates is known to be increasing in areas such as the lower mainland, Osoyoos, and Grand Forks. This is normally caused by inadequate or poorly managed septic systems, animal feedlots, manure storage facilities, and excessive quantities of nitrogen-rich fertilizers. As groundwater testing is extended throughout the province, progressively more areas of contamination may be discovered, largely in agricultural areas or in the vicinity of landfills. Another problem is associated with a few localized areas of salt water intrusion in the Cowichan area and sporadically in the Gulf Islands.

Thus groundwater management appears to be a potentially important problem area in future. Although a 1983 amendment to the Water Act permits the government to regulate groundwater, this provision has not been used (B.C., 1979c: sect. 5).

A limited response to this problem is required in which legislation is adopted that permits groundwater licensing by the Ministry of Environment for the quantity of water used and the quality of water discharged to the soil. At the same time, reconnaissance investigations should be undertaken in the areas of highest potential contamination. If serious levels of degradation are detected, appropriate management strategies can be developed in cooperation with other ministries. Ultimately, sustainable management policies will be required for specific aquifers, agricultural regions, or perhaps political units based on the integrated actions of the Ministry of Environment, all land use ministries, and water users in the areas affected. In some instances, new water and land use policies may be necessary for agriculture, forestry, other industrial sectors, and urban communities to protect aquifers.

RIVER BASIN PLANNING

Federal-provincial cooperation in managing river basins in British Columbia during the 20th century has been limited. Initially, there was action concerning engineering and flood control aspects of the Columbia River to enable the development of hydroelectricity. And a comparatively comprehensive preplanning study was undertaken by both senior levels of government in the early 1980s in the Thompson basin but never expanded into a full study. Subsequently, Environment Canada has been compiling internal overview documents of available data and development opportunities in a number of watersheds for its own use.

In spite of the importance of river basins to British Columbia, the era of river basin planning initiatives which swept across North America and much of the world during the 20th century never had much of an influence in this province. But this was not due to an absence of federal interest. Indeed, river basin planning was formally promoted under the Canada Water Act of 1970. This legislation allowed the federal government to enter into agreements with provinces to promote planning for large watersheds. The approach was intended to develop flexible plans which are adaptable to changing circumstances, to involve the publics in a meaningful way, and to consider the role of coordinated actions in meeting multiple objectives. British Columbia worked with Environment Canada on part of the Okanagan Valley, a comparatively small drainage, in formulating a management plan. And there was federal-provincial cooperation in the small portion of the Yukon basin located in British Columbia in the 1980s.

There have also been two additional ad hoc cooperative institutional mechanisms established to examine the development potential of specific basins, the Flathead and Skagit. Otherwise, the province has opted to work independently of the federal government in planning and managing the other river basins of the province. Instead of attempting a synthesis of management opportunities, and making trade-offs among these throughout the major drainages, provincial management responsibilities have been divided among agencies which deal exclusively with individual resources: forests, minerals, fish, wildlife, agriculture, water, energy, parks, tourism. These interests have not been reintegrated for management decisions by river basins. Indeed, few other agencies except for B.C. Hydro, the Water Management Branch of environment, and federal and provincial fisheries consistently organize their data by river basins. And river basin study teams empowered to synthesize development options, and make recommendations to

government, have never been created except for some aspects of the Okanagan, Flathead, and Skagit basins. Unlike the Prairie and Maritime provinces where federal resources to assist with water planning have been actively solicited, federal expertise and funding have never been systematically used by British Columbia to proactively consider joint development opportunities in the major provincial drainages. Given this institutional vacuum, decisions concerning the provincial rivers have largely been based on project-by-project approvals.

The Ministry of the Environment has completed the most extensive assessment of river subbasin plans in the province to date. In total, critical biophysical appraisals have been completed in 16 of 43 drainages throughout the province where management conflicts have arisen. These deal with water and air quality, fish, wildlife, and noise. The studies are being conducted under the mandate of the Environment Management Act (B.C., 1981). Section 1 of the act defines environment in a biological sense, with respect to air, land, and water. Section 2 empowers the minister of environment to plan, research, and investigate any aspect of the management, protection, and enhancement of the environment.

Although a strategy has been developed for undertaking such studies over the past decade (O'Riordan, 1983), there is little grounds for optimism that this work will be expanded quickly throughout the province. The ministry has been unable to fully implement this program, nor develop the resource inventories required for rapid assessment of small drainages. At present, there is no capacity to assemble a comprehensive overview of environmental values throughout the provincial river basins within the immediate future.

The consequence of this history is that uneven data bases exist today among provincial and federal resource agencies, which serve as the basis for determining long-term development priorities for the provincial river systems. None of the agencies has had resources to prepare a long term plan outlining its bargaining position with which it can debate the merits of alternative development options promoted by other agencies. Indeed, no federal or provincial government agency, has attempted to create a province-wide management plan for its area of responsibility in the major rivers of British Columbia based on solid data and widespread public debate.

PUBLIC INVOLVEMENT

Public input should be solicited for criteria setting, objectives determination, and use designation in water and related resource management. This is because the public is

willing to, and capable of, making a substantial contribution to resource allocation decisions. Public consultation can strengthen resource management by broadening the scope of issues, providing a wealth of expert advice, local knowledge, and exposing alternatives which, otherwise, might be overlooked. It also facilitates dissemination of information, and reduces misapprehension and conflict.

Although there is a fair degree of public participation in public policy formulation, the process could be improved by:

a. ensuring greater public involvement in planning, implementation, and monitoring of policies and programs;
b. assisting the public in making informed decisions on a development proposal by granting easy access to all relevant information; and
c. promoting the formation and operation of public advisory committees to involve the public in program development and decision-making processes.

A SUMMARY ASSESSMENT

The legislation and institutions which govern water planning and management in British Columbia are a product of the changing goals, objectives, and values of society during the 19th and 20th centuries. They served the province well by opening up wilderness areas, creating jobs, and developing the economy. But the time for single-purpose development has passed and the province is entering a new era of integrated resource management. Whereas corporate profitability, jobs, and government tax revenues were the overriding decision criteria, these are being augmented by new concerns. They include: maintaining ecological and economic diversity and stability; minimizing economic, social, and biophysical side effects of development projects; improving mechanisms of determining and including social preferences in decision-making; and using risk aversion to determine development options.

As the province begins experimenting with means to implement a new approach to resource stewardship, based on sustainability within an integrated resource management framework, several facts should be kept in mind.

1) In the interest of industrialization, large water allocations have already been made for certain out-of-stream uses in specific basins;

2) Comparatively, few allocations have been made throughout the province for instream uses such as fisheries, wildlife, birds, recreation, and tourism;
3) Currently there are not enough personnel in the B.C. Ministry of Environment and other resource agencies to collect and analyze the data necessary to understand the dynamics of river basins and aquifers in the province, as well as the cumulative effects of development on these systems;
4) Many existing agency personnel have neither training nor experience in working in public forums to achieve mutually agreeable management strategies among competing water users; and
5) The publics who consider themselves as stakeholders in some component of the water and related biophysical resources of the province have never been given adequate opportunities to express their long-term management preferences for the river basins of the province.

For these reasons, the transition to institutions which promote sustainable management from the current single-purpose approach will be prolonged, frustrating, and costly. But the potential payoff to future generations is well worth the effort if sustainable resource and industrial management systems can be fashioned to form a stable basis for the British Columbia economy for the 21st century. Some desirable changes to make this possible are discussed next.

THE WATER ACT

This legislation requires a complete restructuring and better integration with other provincial legislation which governs the use of forests, agriculture, lands, tourism, parks, fisheries, wildlife, and waste management. In addition, the restructured act should be flexible enough to respond to changing policy contexts and new demands, promote resource conservation, provide incentives for efficient water use, and reinforce the concept that water is a scarce and valuable resource. The revised act should include the following provisions.

A Planning Mandate. The Ministry of Environment needs to be empowered to analyze existing water resources, emerging quality and quantity problems, the physical limits of development, and to undertake planning.

The provincial Water Act is the principal legislation used to adjudicate applications for water use, although federal fisheries' concerns may influence the final decision. This

approach to water allocation by river basins is incomplete and inadequate. When the Water Management Branch completes its current program of computerizing available water supply and allocation data, it will need to develop a new allocation system. This should sanction the active involvement of all stakeholders--agriculture, urban, forestry, mining, fisheries, wildlife, tourism, recreation, parks, and other water users--in establishing base flow requirements by subbasin, permissible levels of disturbance to base flows, and acceptable uses. A system that considers the needs of all users prior to development would constitute a major advance in the management of British Columbia rivers.

Another important deficiency in the current water allocation system is that it is reactive. To correct this, the Minister of Environment should further improve the current planning approaches, and also consider other land and water management issues which are currently ignored in the Water Act. Such an approach would enable the province to evaluate a range of potential alternative allocations long before specific developments are proposed. For example, the Northwest Power Planning Council placed 44,000 miles of the streams in the Columbia Basin off-limits to hydroelectricity in 1989 to protect fisheries habitat (Lee and Kneese 1989: 1). Proactive planning of this nature could be applied to many resource interests in British Columbia to clarify in advance where specific uses are acceptable or desirable.

New Priorities. The uses which are not currently recognized as legitimate in the act--fish, wildlife, tourism, and recreation--should initially receive preferential treatment in future water allocations. This special status should continue until these ignored instream uses have been adequately inventoried in terms of the potential of the provincial river systems to support them. Future water allocations within all basins should be made in light of the commitments already made for various water uses with specific basins and throughout the province.

Transfer of Water Rights. Two systems are desirable to permit a change among holders of water rights. The first occurs when water is no longer used because, for example, a mine closes. In such instances, water associated with the license reverts to the crown. This requires field investigation to determine the current level of water use.

In other circumstances, there will be changes in the profitability of different industries over time. The new legislation could permit the trading of all or part of active water licenses so that willing buyers and sellers could exchange rights among approved water uses. Such a

reliance on the market in allocating water resources could complement the present regulatory system, especially where the ministry has insufficient resources to enforce compliance with allocation permits. Potential trades should be subject to approval by the Ministry of Environment to ensure that all other social needs are considered before sales are finalized.

COMMUNITY WATERSHEDS

The policy of allowing integrated resource management in community watersheds on crown land in British Columbia has been a continuing source of conflict. Neither the Ministry of Environment nor the Ministry of Forests has the necessary resources to prepare integrated watershed management plans which are intended to safeguard public water supplies for these areas. Either funds and personnel to do this work should be made available, or no new forestry and mining operations should be allowed in areas where domestic water supplies are threatened until plans are in place to protect community water supplies.

HYDROELECTRICITY

British Columbia Hydro has traditionally had a competitive advantage over governmental resource management agencies because of its comparatively large level of funding and personnel available for policy and project-related studies. As a result, the utility identified the major hydroelectric basins and development sites long before other governmental agencies had funding and manpower to assemble comparable inventories for competing water and land uses.

The threat which hydroelectric developments pose to competitive resource management options in the rivers of British Columbia was dramatically reduced in 1990 by twin policies adopted by B.C. Hydro at the suggestion of the British Columbia Utilities Commission (1990). These relate to its new goals of minimizing environmental degradation and of promoting energy conservation by a variety of means. As a result, the large new hydroelectric energy sources fell to a comparative low priority. Hopefully, other provincial and federal resource agencies can use the first half of the 1990s to assemble inventories of the potential which specific river basins of the province have to serve a variety of needs. Such data will be needed to make the difficult decisions on the long-term allocation of water to permit sustainability of competing uses in coming years.

Now that B.C. Hydro has adopted its new energy policy, the major unknown factor in the export of hydroelectric energy from the province is the priority that the minister of energy,

mines and petroleum resources, and the provincial cabinet assign to electricity export. It is also unknown whether the government priorities are the same as B.C. Hydro's. To the present time, British Columbia publics have not been given the opportunity to debate the relative merits of alternative hydroelectric development scenarios as well as other development options for provincial rivers. If a new agency were empowered to begin the process of formulating sustainable resource use plans for the major provincial rivers as is suggested above, a forum to consider this important policy question would be available for the first time.

AGRICULTURE

Agricultural practices exert pressure on water quality and quantity. In semiarid areas, such as in the southern interior, there is inadequate water supply to meet the aggregate demand. New priorities are needed to guide water allocation for farm and nonfarm uses. There is also inadequate legislation to regulate water quality. The provisions under the Pest Control Act and Waste Management Act do not cover all farm and related practices. Application, storage, transport, and disposal of manure, fertilizer, and pesticides are examples of where stricter regulation is required for sustainable water management. And the proposed committees representing the agricultural community which would adjudicate water-related complaints also appear to be a useful innovation.

FORESTRY

Traditionally, timber harvesting practices have been detrimental to other forest-related resources. Comparatively little attention has been given to other values such as fish and wildlife populations, habitat protection, recreation, tourism, and esthetics. In future, it should be necessary to consider such forest-related uses more openly, as well as to predict the hydrological consequences of forestry practices in an effort to understand the consequences of timber harvesting on the sustainability of other resources and industries.

PUBLIC INVOLVEMENT

Traditionally, the Province of British Columbia has created discretionary ministerial requirements to consult the public on most resource development decisions. The regulatory ministries have strong linkages and ongoing consultation with the industrial groups which they control. But public hearings normally are only held when groups of citizens become so disturbed by potential projects associated with forestry, hydroelectricity, mining, parks, or other changes that a public forum of one sort or the other is organized in an attempt to defuse a situation.

Probably, most important is the wide range of decisions that can be taken by affected provincial and federal government ministers without consulting the affected publics. The 1987 Alcan decision exemplifies how citizens with important social, economic, and environmental concerns can be excluded from a decision making process. Nor can citizens use the courts to be heard in such environmental matters, due to legal technicalities such as the difficulty of getting legal standing, burden of proof, and lack of intervener funding. Although the forthcoming Federal Environmental Assessment Act may reduce the probability of such secrecy when federal interests and responsibilities are involved, there have been no comparable provincial legislative initiatives to redress this problem. As a consequence of the current institutional system, British Columbia citizens have never been given the opportunity to comment on most management policies which have implications for resource sustainability.

GROUNDWATER

This component of the provincial resource base should be included in the Water Act. In the isolated areas of potential groundwater contamination in British Columbia, more manpower and funding is required on a pilot-study basis to determine what needs to be done to control contamination. This experience should then be used to establish the degree of government regulation which will be required to manage groundwater on a sustainable basis. Better control may be required over herbicides, pesticides, agricultural chemicals and wastes, industrial and municipal wastes, and other sources of water degradation.

RISK, UNCERTAINTY, AND DEVELOPMENT OPTIONS

A strong case can be made for not fully licensing the water in the subbasins of the province. Probably most compelling among these is the unpredictable effect which current anthropogenic atmospheric changes might have on water availability in the 21st century (Moss and Lins, 1989). For this reason, as well as for the possibility of changing patterns of water demand, it would be prudent to adopt a strategy of not overcommiting the available water resource. By keeping some water in reserve until the ability to forecast runoff improves, the probability of achieving goals established for sustainable water and water-derived services stand a better prospect of being met.

AGENCY FUNDING AND PERSONNEL

An aspect not sufficiently investigated in this report is the level of staffing available to undertake the suggested planning and management initiatives. However, based on the discussions undertaken for this study, it is clear that the ministries of tourism, and environment require substantially more manpower and funding if improved management systems are to be undertaken. No doubt, the other resource agencies also would be hard pressed to do more with existing resources. Any recommendations to introduce sustainable management systems in the province will need to consider the kinds of expertise needed to do the work as well as the adequacy of present agency budgets to undertake the work.

RIVER BASIN PLANNING

Irreversible decisions will continue to be made on the future use of British Columbia rivers. At present, there are limited checks and balances in the provincial institutional system to ensure that a full public debate of the critical values involved will be possible. The current institutional system does not permit a provincial or region-wide assessments of water and land development alternatives in all river basins of British Columbia. Without an appropriate institution to undertake this work, and the necessary intelligence, the province is ill-prepared to make any decisions on the desirability of potential development options.

Three provincial institutions have played a major role in planning and managing British Columbia rivers during the 1980s: the Ministry of Environment, B.C. Hydro., and the B. C. Utilities Commission. Perhaps none of these is the appropriate body to make the necessary trade-offs among potential uses as the province begins to experiment with institutions to implement sustainable management.

The Ministry of Environment appears to be the strongest candidate for this task because of its traditional role as the adjudicator in making trade-offs among competing water uses and its experience in formulating subbasin plans. But the ministry has a potential conflict of interest, because it also acts as an environmental advocate by protecting fish, wildlife, and air and water quality, much like other provincial ministries which are also proponents. As a result it could be argued that the ministry might have a bias in making trade-offs, or that its ability to ensure the sustainability of the interests which it represents is not compromised by the need to reach agreement with other stakeholders.

The B.C. Utilities Commission (BCUC) has reviewed and certified the construction and operation of major hydroelectric projects during the 1980s (B.C., Revised Statutes, 1980).

In rejecting the proposed Site C dam as unnecessary in 1983, it had a major impact on the Peace River basin. However, the BCUC mandate is too narrow, and it also has a potential conflict in its role of regulating hydroelectric development.

Thus, what is needed is a new, professionally staffed, permanent, river planning and management agency comprised of broadly trained resource managers. It should not regulate a specific component of the environment. Its role would be to develop sustainable management plans for water and related resources in each major provincial river basin and subbasin as well as for the system of provincial rivers. Such a body could report directly to the Sustainable Development Committee of cabinet. It would clearly be a strong candidate to designate special round-table type panels for specific basins under the sustainable development initiative in the province (B.C. Task Force 1989: 21-26).

The agency should combine industrial, governmental, and public interest groups which promote development, preservation, and sustainability in its organization. In the early phases of its work, the committee should be directed to conduct and solicit research and prepare background documents on the current situation from the perspective of the major actors involved: industry, government, labor, and other interests. Then public hearings and workshops could be held throughout the province. Its immediate mandate should be to give the provincial government advice on the range of feasible planning and development options for all of the major provincial river basins before further major decisions are taken. Over the long term permanent, but small, planning and coordinating bodies would be needed for each major provincial drainage. These should act as clearing houses for relevant information and provide a forum for debate and conflict resolution related to ongoing management concerns among all interested parties. They could also liaise with affected interests on environmental and socioeconomic matters which influence major rivers.

To continue the current project-by-project approval process would run the risk of impairing, or destroying, potentially viable development options. The institutional change suggested here would begin the process of formulating policies and plans which would consider all sustainable management options throughout the system of provincial rivers. But the establishment of new priorities on the relative importance of water and related resource uses also implies major shifts in the machinery of government. Because water cuts across many aspects of government policy, the new agency could also assist in selecting an

appropriate balance of uses within specific river basins and then in coordinating sustainable management policies among the affected ministries.

INTEGRATING SUSTAINABLE DEVELOPMENT POLICIES

There are a variety of factors in the current legislative and institutional system which impede the rapid introduction of sustainable development policies for water and related resources. These include: a lack of clear management objectives, the consideration of limited social values in planning decisions, bureaucratic politics, and inadequate information (Canadian EARC, 1990: ix).

In addition to the required direct legislative and institutional changes, complementary policies are also required for a comprehensive approach to sustainable water management. Examples of the complementary policies include: the setting of sustainable water management and related resource development objectives, a larger commitment to environmental science, improved public consultation mechanisms, more effective evaluation indicators, conducting post audit assessments, and increasing the logistical support of relevant agencies.

RECOMMENDATIONS

1. Legislate Instream uses. The B.C. Ombudsman recommended that a comprehensive legislative foundation should be provided to ensure fairness, certainty, and predictability in integrated resource management (B.C., Ombudsman's Report, 1988). To do so, a legal framework should be established in situations where conflicts are anticipated. Legislating instream uses is a means of providing a more level playing field for all major water users. Amending the relative priorities of competing uses in the Water Act is another.

2. Negotiated Agreements. In each river basin, or major subbasins, a committee consisting of all governmental and private stakeholders in the water resource should negotiate river basin management agreements. This would be in line with the Ombudsman's recommendation for a consensual conflict resolution mechanism, one which relies on negotiation rather than litigation, and on creative alternatives in reconciling competing interests. In this approach the new river basin management body could act as a facilitator or a neutral mediator, to ensure balanced decisions.

3. The current discretionary referral process among provincial interests should be formalized. If MOE continues with its current discretionary allocation process, decision making should occur within a more open and structured framework to enhance public confidence in the impartiality of its judgments. To do so, the criteria for allocation decisions should be made explicit and reasons for decisions taken made public.

4. A nonpartisan agency, independent of resource development interests, should be created to oversee the planning and implementation of provincial water policies. There has been considerable experimentation with alternative institutional forms for river basin and regional water management in North America and elsewhere during the 20th century, and particularly in the 1980s. No doubt, some of these will be better than others in terms of their applicability in British Columbia. These experiences could provide valuable lessons to reduce the cost and time required to begin the process of learning how to manage the water and related resources of British Columbia in a sustainable manner.

5. One of the greatest challenges in moving to a system of sustainable water and related land management is to be able to measure the degree to which new policy goals have been achieved. To do so, some landmarks of success would be desirable, such as a system of indicators which report changes in key variables, or periodic state-of-the-environment reports. An authoritative agency, free of political influence, would be the most reliable kind of unit to ensure that such assessments are reliable.

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